THE MUNICIPAL WATER SUPPLY SYSTEM

OF

THE CITY OF NEW YORK

A General Description

DEPARTMENT OF WATER SUPPLY,
GAS AND ELECTRICITY.

Nicholas J. Hayes, *Commissioner*
John J. Dietz, *Deputy Commissioner*
Merritt H. Smith, *Chief Engineer*
William W. Brush, *Deputy Chief Engineer*

May, 1920.

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Birdseye View of Watersheds and Lines of Aqueducts of the Catskill, Croton and Long Island Systems.

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GIFT

The Municipal Water Supply System of the City of New York

Of the 6,000,000 inhabitants, more or less, of New York City, all but about 400,000 are supplied with water by the municipality. Such 400,000, constituting a portion of the inhabitants of the Boroughs of Brooklyn and Queens, are supplied by private water companies. This pamphlet deals principally with the municipal water supply system and the work incident to the care, operation and development thereof, which work is confided by statute to the Department of Water Supply, Gas and Electricity. The department's jurisdiction and principal duties in relation to this work are as follows:

1. It has jurisdiction, charge and control (a) of the sources of supply of all water furnished by the City, (b) of all water supply structures owned by the City, including reservoirs, dams, aqueducts and gatehouses, and (c) of the City's distribution system, including pumping stations, water mains, valves and fire hydrants. It supplies about 5,600,000 people with water for domestic and business uses and for fire protection, and in so doing operates and maintains the greatest municipal water supply system in the world, of an estimated cost of $341,500,000.

2. It is responsible for the quality of the water, whether supplied by the City or by private water companies.

3. It operates through electrically driven pumps the high pressure fire service in Manhattan and Brooklyn and through gas driven pumps that are at Coney Island.

4. It collects the water revenue, amounting to about $15,000,000 per annum.

5. In conjunction with the Board of Aldermen it fixes the rates at which water supplied by the City shall be sold.

6. It tests water meters. It may require their installation in places where water is supplied for business purposes and it inspects and reads some 108,000 at regular intervals. It may recommend to the Board of Aldermen their installation in residential premises and there install them with the consent of such Board.

7. It determines the location and supervises the construction of all sub-surface structures (including water mains, gas

mains, electrical conductors, steam pipes and pneumatic tubes), except sewers and rapid transit lines.

8. It supervises the operation of the private water companies in Queens and Brooklyn and has jurisdiction to fix their rates for water, its determination as to rates being subject to review by the courts.

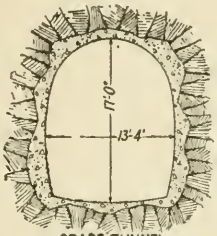
At the head of the department is a Commissioner, appointed by the Mayor. It has three operating bureaus, the largest of which is the Bureau of Water Supply. At its head is a Chief Engineer, appointed by the Commissioner and responsible to him for the operation and maintenance of the water system. Of the 2,100 employees of the department, 1,470 are attached to the Bureau of Water Supply. The water revenue is collected through the Bureau of Water Register, which bureau also inspects all premises to determine the proper water charges, establishes consumers' accounts, examines fixtures and reads water meters. Electric current for the operation of the high pressure fire service pumps is provided through the instrumentality of the Bureau of Gas and Electricity. No reference will be made to departmental duties not relevant to the subject matter of this pamphlet.*

HISTORICAL.

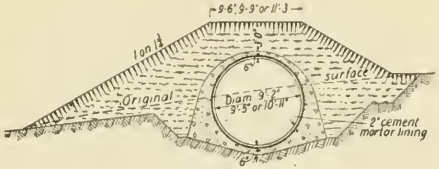
The present City of New York is the result of a consolidation in 1898 of two great cities and various adjacent communities. Their water supplies were developed without regard to the present city limits and it was not until 1917 that New York was served by a system planned for the city as a whole. A brief reference to the principal features of the important earlier systems will prove interesting.

The Borough of Manhattan, constituting the old City of New York, had, until 1842, no general water supply system, although its population at that time amounted to over 300,000. The early settlers obtained water exclusively from wells, some of them constructed by the city in the important streets. The first general scheme for a supply of water actually put into operation was adopted by the Manhattan Company (now the Manhattan Bank), which, in 1800, sunk a well at Reade and Centre streets, pumped water therefrom into a reservoir on

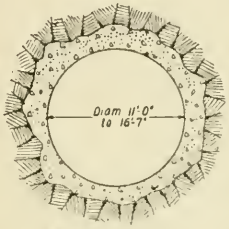
*All Catskill construction work is under the Board of Water Supply, a separate organization. As such work is completed it is transferred to the Department of Water Supply, Gas and Electricity for maintenance and operation.



GRADE TUNNEL
(Kensico Reservoir to Hill View Reservoir, 17'6"×13'9")

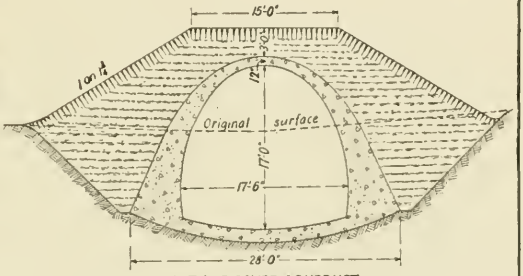


STEEL PIPE SIPHON
(Three pipes for each siphon)



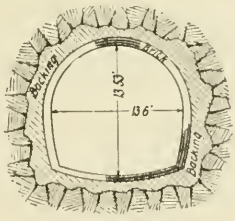
PRESSURE TUNNEL

Rondout Wallkill	14'6"
Moodna	14'2"
Hudson, Breakneck Croton Lake	14'0"
Yonkers	16'7"
City Aqueduct	11' to 15'

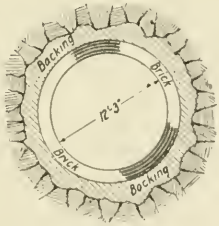


CUT-AND-COVER AQUEDUCT
(Kensico Reservoir to Hill View Reservoir, 17'6"×18'0")

CATSKILL AQUEDUCT

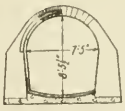


GRADE TUNNEL



PRESSURE TUNNEL

NEW CROTON AQUEDUCT



OLD CROTON AQUEDUCT

BROOKLYN AQUEDUCT

Cross Section of New York City Aqueducts.

Chambers street and distributed it thence through wooden mains to a portion of the community, which, at that time, consisted of about 60,000 inhabitants. The maximum amount supplied by this company was about 700,000 gallons a day. The initial step taken by the old city of New York in reference to public waterworks was the construction, in about 1830, of a reservoir at Thirteenth street and Broadway. After consideration of numerous schemes looking to the creation of a suitable general supply, it was decided to build an aqueduct from the Croton River to the city, to be supplied by one storage reservoir, which aqueduct (known to-day as the Old Croton Aqueduct), with a capacity of 90 m.g.d.,* was opened in 1842. This was an event of great importance in the history of older New York. The distribution reservoirs were at Forty-second street (abandoned in 1890) and in Central Park, south of Eighty-sixth street, the latter being the rectangular reservoir soon to be abandoned. In due course this aqueduct became inadequate and in 1883 a commission was formed to build a second one from the Croton watershed as well as additional storage reservoirs in that watershed. The second aqueduct, known as the New Croton Aqueduct, was under construction from 1885 to 1893 (though it was used as early as 1890), and has a capacity of 300 m.g.d.*

Of the former Bronx water supply it is sufficient to say that in recent years nearly three-quarters thereof came from the Croton and the remainder from the less important Bronx and Bryam watersheds. The waters from the latter, yielding about 20 m.g.d., were until recently delivered into a pipe line over fifteen miles long, leading from the former Kensico Lake to the Williamsbridge reservoir in the Bronx. This lake has now been merged in the new Kensico reservoir, and at that point the waters from the Bronx and Byram watersheds become merged in the new Catskill supply.

A distinguishing feature of the supplies from the Croton, Byram and Bronx watersheds is that they have always been delivered to the boroughs in which they were used by gravity, though it was necessary thereafter (and it still is necessary) to pump a portion of the Croton water to obtain adequate pressures to reach certain high ground. On the other hand, the former municipal water supplies of Brooklyn, Queens and

Note.—"M.g.d." stands for "million gallons daily."

Richmond were collected for the most part by wells and infiltration galleries. It was necessary, at a great expense, to pump the water from the ground and also, as a rule, thereafter to an appropriate elevation before it could be sent into the mains for distribution. The former City of Brooklyn, like the former City of New York, did not develop a public water supply system until its population had reached nearly 300,000. the use of local wells and cisterns being the only sources of supply prior to 1859. In that year the city began sending water collected on the south side of Long Island into its distribution system. The original works ran easterly to the Hempstead Valley. Later they were extended to Massapequa, Long Island, and the great Milburn and the Ridgewood South Side pumping stations constructed.

For the Borough of Queens no municipal waterworks of magnitude have been constructed. Prior to 1913 the First Ward was served by three local municipal pumping stations and by private water companies. Between 1913 and 1917 it was served largely from the Brooklyn watershed. The Third Ward, prior to 1917, was served by two municipal pumping stations, while the Second, Fourth and Fifth Wards were and still are supplied by private water companies, their sources of supply being ground water collected by means of driven wells.

Prior to 1917 the Borough of Richmond was dependent for its supply on ground water drawn from wells. Until 1909, except as to Tottenville, it was served by private water companies, the principal of which were in that year acquired by the city. The last of the private companies in this borough was acquired by the city in 1917.

Some twenty years ago the necessity was foreseen of providing a large additional water supply for the use of Greater New York, but it was not until 1902 that definite steps were taken to formulate and execute such a plan. In that year a commission of engineers was appointed which, after careful study, recommended that the city go to the Catskills for additional water. In 1905 the Board of Water Supply—not to be confused with the Department of Water Supply, Gas and Electricity—was created by act of the Legislature and proceeded forthwith to plan and construct the works for impounding the waters of the Esopus, one of the four watersheds in the Catskills, upon which the city had planned to draw,

Ashokan Reservoir.

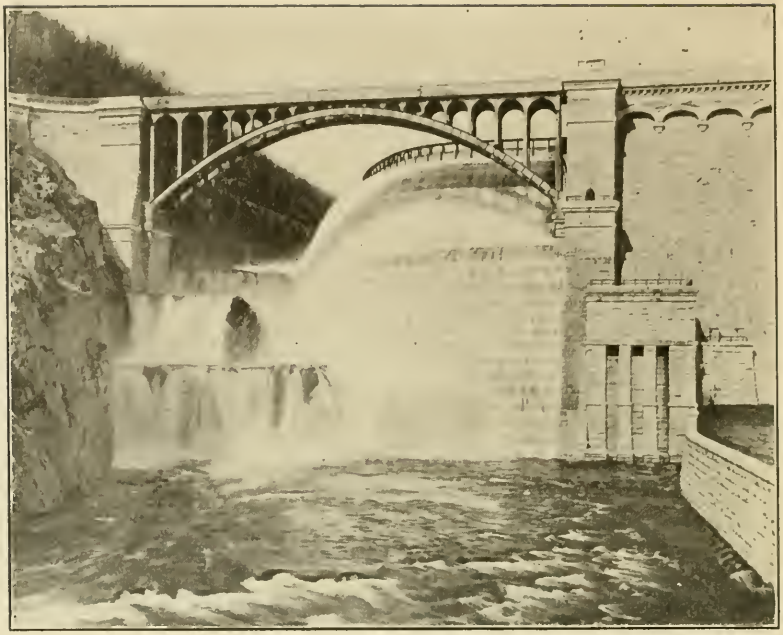
Ashokan Reservoir Spillway.

and for delivering such waters throughout New York City. This mounmental work, commonly known as the Catskill system, was successfully completed and turned over to this department for operation in 1917. The Board of Water Supply is now engaged in developing another of the Catskill watersheds, the Schoharie, from which it is expected to derive about 250 m.g.d. beginning with the year 1924.

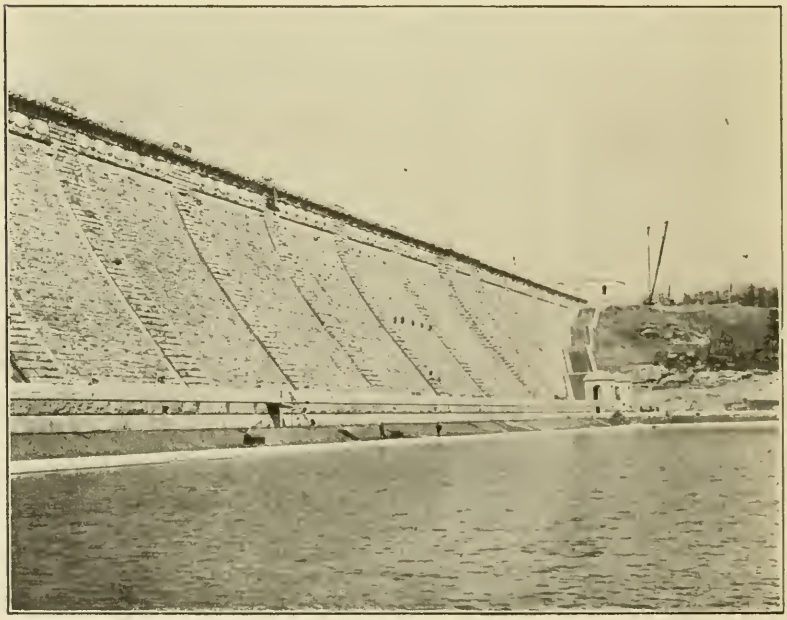
WATERSHEDS, RESERVOIRS AND AQUEDUCTS NOW IN USE—THE CATSKILL AND CROTON SUPPLIES.

The municipality now draws its water almost exclusively from (1) the Esopus (Catskill), (2) the Croton, (3) the Byram and Bronx watersheds. Some 7 m.g.d. is drawn from wells in Richmond to supplement the Catskill supply and at times slightly over 20 m.g.d. has been drawn from the Long Island watershed to reduce the draft on the Catskill system in Brooklyn. As a result of the introduction of the water from the Catskills, the city's watersheds on Long Island and Staten Island are now largely in disuse. How soon the reserve supply will be again drawn on depends on a number of factors, such as the growth of the city, the future per capita consumption of water and whether or not other sources of supply are developed. The aqueducts in use at this time are the Catskill and the new Croton, the old Croton aqueduct being held in reserve. Brief descriptions of the Catskill and Croton systems follow.

The Esopus watershed in the Catskill Mountains, with an area of 257 square miles, has been developed to yield a safe minimum of 250 m.g.d., the precise amount varying with the rainfall. The average present draft is about 375 m.g.d. Its waters are collected in the Ashokan reservoir, with an available capacity of 127,700 m.g. and at an elevation of about 590 feet. This capacity can be increased to 130,400 m.g. by placing flash boards on the overflow dam. The water from this reservoir is sent by gravity into the five boroughs of the city. It first passes through the Catskill aqueduct, which extends a distance of ninety-two miles from the Ashokan reservoir to the northerly city limits, crossing the Hudson by means of a tunnel in rock at Storm King Mountain at a depth of 1,114 feet below sea level. From the city limits it passes through the Bronx and Manhattan by means of the continua-



Croton Dam and Spillway.



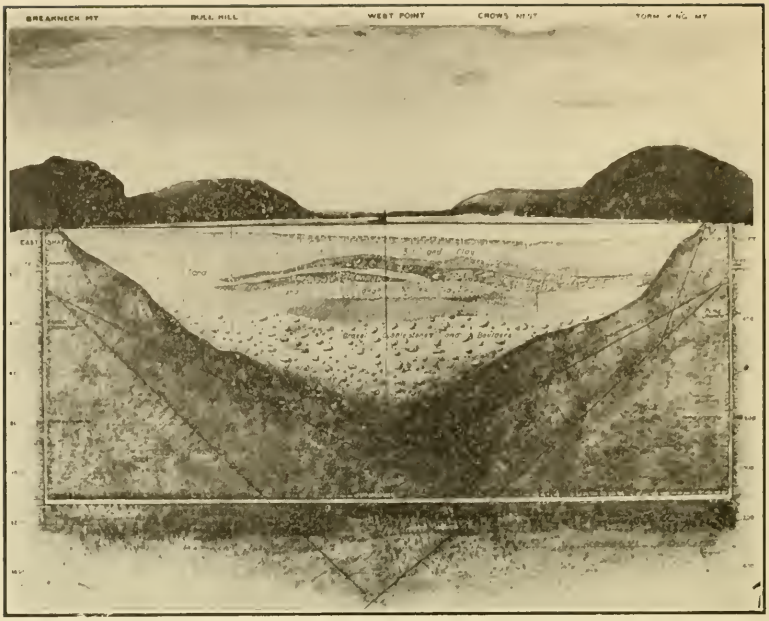
Kensico Dam.

tion of the aqueduct, known as the City Tunnel, lying from 200 to 750 feet below the street surfaces, thence beneath the East River to two terminal shafts in Brooklyn, whence steel and iron pipe conduits carry it into the boroughs of Queens and Richmond. The conduit leading to Richmond passes beneath the Narrows. The terminal of the Catskill system is Silver Lake reservoir on Staten Island, with a capacity of about 438 m.g. The distance from Ashokan reservoir to Silver Lake is about 120 miles, and at the average velocity of flow the water requires about three days to travel this distance. The Catskill aqueduct is twice as long as the greatest Roman aqueduct.

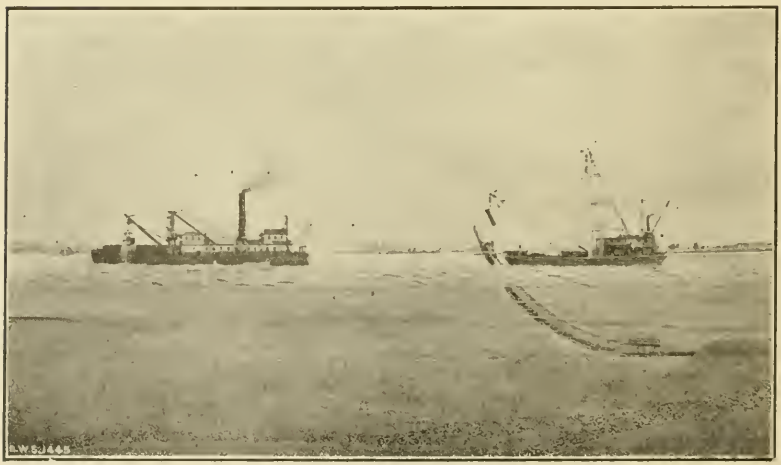
Kensico reservoir, with an available capacity of 30,573 m.g. (or sufficient to supply the city with water for about two months,), has been built on the line of the Catskill aqueduct, near Valhalla, as a storage reservoir for the purpose of maintaining the supply of the city when the aqueduct north of that point may be temporarily out of service. As already stated, it receives also the water from the Byram and Bronx watersheds. Hill View reservoir, located within the limits of Yonkers and fifteen miles south of Kensico reservoir, has been constructed to regulate the flow of water as between the aqueduct, where it is relatively steady, and the city mains, in which it varies from hour to hour. It holds 929 m.g. of water and has a depth of 36½ feet. Its elevation of 295 feet above sea level determines the "head" of the Catskill supply.

The Catskill aqueduct is either circular or horseshoe in section, with a maximum height of 17½ feet and a capacity of at least 500 m.g.d. It will not be utilized to capacty until the Schoharie watershed shall have been developed (at which time additional pipe siphons across certain valleys must be built, as the present siphons limit the capacity to about 375 m.g.d.). The Catskill supply is delivered to the street mains in the boroughs of Manhattan and the Bronx through nineteen waterway shafts, and from the Brooklyn terminal shafts large, steel pipe conduits have been laid in the streets to supply the boroughs of Brooklyn, Queens and Richmond.

The Croton watershed has an area of 375 square miles and may be counted upon to yield a minimum of 336 m.g.d., the average yield being 400 m.g.d. Its waters are collected through twelve storage reservoirs and six controlled lakes, the



Catskill Aqueduct Passing Beneath Hudson River North of West Point.



Construction of Catskill 36-Inch Pipe Line to Staten Island Beneath the Narrows.

lowest and largest of which is known as Croton Lake about 20 miles long. At the westerly end of this lake is the Croton Dam, an imposing masonry structure built between 1892 and 1905, at a cost of approximately $17,000,000 (including land). The spillway of this dam is at an elevation of about 200 feet. The total available capacity of all the reservoirs on this watershed is 104.443 m.g. The two Croton aqueducts have a combined capacity of 390 m.g.d., or slightly less than the average yield above mentioned. The length of each to the city line is about twenty-four miles. The old aqueduct crosses the Harlem River at and by means of Highbridge, while the new aqueduct passes underneath the Harlem River near 180th street at a depth of 300 feet below the river surface. Practically all Croton water reaching Manhattan is carried to the gatehouse at 135th street and Amsterdam avenue, except that taken from the new Croton aqueduct at the pumping station at 179th street and Harlem River. From the gatehouse all Croton water goes by gravity into the mains, either directly or through the distributing reservoirs in Central Park, except that which may be sent to the pumping station at Ninety-eighth street and Columbus avenue. The Central Park reservoirs have an elevation of 119 feet.

QUALITY OF THE WATER.

The city makes unremitting effort to keep the water free from pollution.

(a) A uniformed force under a sanitary expert is engaged in patrolling the watersheds to detect and abate sources of contamination and to see to it that the department's sanitary rules and regulations are observed.

(b) All water is treated with chlorine. The Croton is so treated at Dunwoodie, near Yonkers; also portions thereof at sundry points on the watershed; the Catskill as it enters the Ashokan reservoir, and also at the Kensico reservoir. The use of chlorine to destroy bacteria is recognized as a generally efficient means of protecting a community against disease being transmitted through its water supply. It is applied in amounts so small (usually about one pound of chlorine to 500,000 gallons of water) that there is no resulting taste or odor.

(c) All Catskill water may be aerated to free it from gases and in some cases from microscopic organisms which, though

and in some cases from microscopic organisms which, though harmless, may nevertheless produce an unpleasant odor or taste. It is only at times that the water requires such treatment. The aerators, each consisting of some 1,800 fountains, are installed at the Ashokan and Kensico reservoirs.

(d) Microscopic organisms which develop in the reservoirs and at times impart an unpleasant taste and odor to the water, though in no sense harmful to health, are destroyed by treatment with copper sulphate.

(e) The department is resisting the installation of additional State institutions on any of the watersheds. Experience shows that the operation of sewage disposal plants (especially at institutions) is liable to interruption, while the general contamination of the water supply resulting from large aggregations of people, many of them undisciplined, residing within a restricted area, is a menace which should not be allowed unnecessarily to arise.

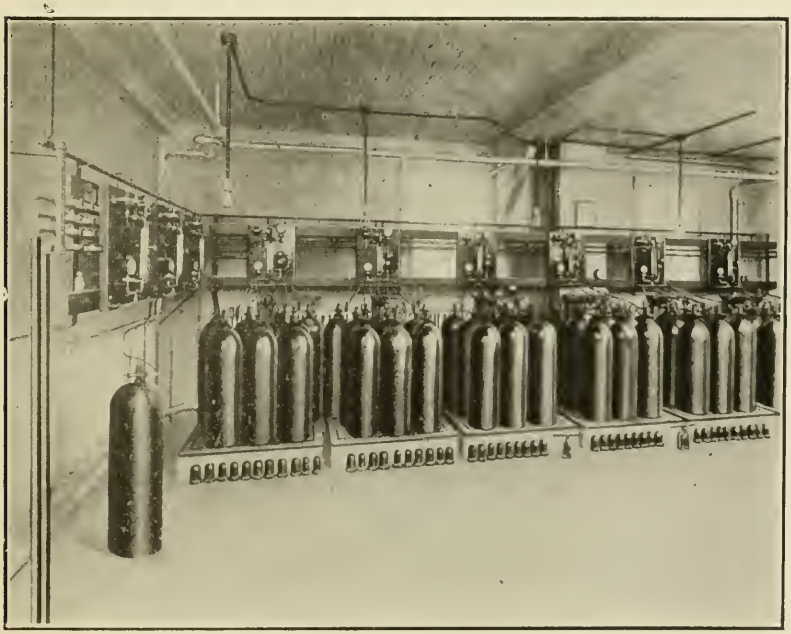
(f) At two laboratories daily bacteriological examinations are made of samples of water taken at seventeen different points. Additional samples from sources of supply which do not require daily investigation result in the laboratories examining over thirteen thousand samples during the year. In case any portion of the supply is shown to be unsatisfactory, either its use is discontinued or the objectionable conditions are ascertained and remedied. The laboratories in question are well equipped with modern apparatus and are located, respectively, at Mount Prospect reservoir, Brooklyn, at Mount Kisco and at the Ashokan gatehouse, where Catskill water is tested.

(g) The department has recently forbidden the introduction of water from any private wells or other auxiliary water supply into the pipes through which water supplied by the municipality flows, unless the same has been first approved by the Board of Health as suitable for domestic use.

How successful the city has been in maintaining the quality of its water is shown in part by the low typhoid death rate, which is now at its lowest known point, namely, 2.0 per 100,000, nor does the department concede that any of these deaths are due to impure water; rather are they traceable to oysters, milk, uncooked vegetables and ice cream, or to disease contracted beyond the city limits.

The quality of the water supplied by the city is excellent

Laboratory at Mount Prospect, Brooklyn.



Chlorinating Plant at Dunwoodie.

for all purposes. At the time of its delivery from the reservoirs into the mains it is clear and wholesome and safer to drink than most bottled waters. If water is dirty as it runs from faucets, this is generally due to rust or accumulations within house tanks or piping, for which the city is not responsible. The Catskill water is particularly well suited for business uses, for it is very soft and very low in iron content and corrosive constituents. A soft water reduces the use of soap in laundries, in silk dyeing establishments and in the household; it aids in procuring correct colors in dyes and in silk dyeing; it affects favorably the operation of powerhouses, breweries and photographic establishments and reduces corrosion in local house piping and other fixtures. A soft water with low corrosive action eliminates to a great extent scale in boilers and corrosion of tubes, thereby reducing the cost of steam production and the probability of accident. The Catskill supply is softer than either the Croton or the former Brooklyn and Queens supplies. The former Richmond supply had a hardness ten times as great at that of Catskill water. The use of softer water will mean aggregate savings of hundreds of thousands of dollars, affecting many classes of consumers in Greater New York.

The question whether or not the water supply of New York should be filtered was considered in 1910, the then responsible authorities reaching the conclusion that it was not necessary to do so at that time. With the growth of the communities on the watersheds and under an insistent public demand the subject will, in due course, undoubtedly again receive attention. Meanwhile, it should be remembered that in addition to the mechanical means of purification above described, the long period of sedimentation in the reservoirs operates still further to purify the water.

CONSUMPTION AND WASTE OF WATER.

The daily aggregate consumption of water within Greater New York exceeds 660 m.g.d., including the 40 m.g.d., more or less, furnished by the private water companies of Brooklyn and Queens. Thus the municipality supplies about 620 m.g.d., or somewhat over 100 gallons per capita to those whom it serves. Figures already cited show that the Croton, Byram, Bronx and Esopus (Catskill) watersheds may, with average rainfall, be reasonably counted on to yield together at least

750 m.g.d., and it follows that just now New York City has available a supply of water well in excess of its needs. Catskill water is being used to nearly the full present capacity of the Catskill aqueduct, because through its greater pressure it constitutes the least expensive of the supplies to operate, and so it comes about that at the present time about three-fifths of the water used is Catskill and two-fifths Croton. As much Croton water as it is possible to distribute by gravity is now being withdrawn for use, and no further substantial amount of Croton water could be used except after pumping to give adequate pressure. For this reason the department selects Croton water as the excess water which shall run to waste, in so far as any must run to waste. This is a vital fact to be remembered in any consideration of the present surplus of water. Other points to be considered are (a) that the annual growth in consumption will absorb more and more of this surplus, and (b) that it will be almost, if not entirely, eliminated by a succession of dry years.

The consumption figures include the water that is lost through leaks in mains and fixtures and wasted through reckless use. This is a large subject with which it is impossible to deal fully here. Since 1912 leaks from water mains and house services within street limits, representing in all 75 m.g.d., have been located and stopped, an amount sufficient to supply a city of about 750,000 inhabitants. The daily aggregate waste within buildings where the services are not metered is known to be a very large amount. The department is, to the best of its ability, endeavoring to reduce such waste through house inspections, but this is a slow process and one in which it is often difficult to secure the required co-operation on the part of the citizens. The most effective known remedy against waste within houses is the installation of water meters, for each householder then has a personal interest in reducing it to a minimum. Leaky fixtures and allowing water to run on cold nights to prevent pipes from freezing are much less likely to occur where the size of water bills depends upon the precise quantity of water used than where a lump sum is paid for the water supplied, irrespective of the quantity used. Meters have been installed generally in New York on services where water is used for business consumption. It should be realized by all that water is not only a product of great value,

but a very costly product by the time it has been placed at the disposal of consumers in a large city. The necessity of conserving the supply is perhaps best illustrated by the fact that the city is now engaged in developing the Schoharie watershed in the Catskills, at a cost of over $20,000,000 in anticipation of the increased requirements of the not distant future.

UTILIZATION OF THE CATSKILL AND CROTON SUPPLIES—PUMPING CROTON WATER TO GIVE IT ADEQUATE PRESSURE.

The uses to which the Catskill and Croton supplies are put are determined largely by the elevation of the respective points from which they flow into the distributing mains. In the case of the Catskill such point is Hill View reservoir with an elevation of 295 feet. In the case of the Croton such points are Jerome Park reservoir, the 135th Street gatehouse and the Central Park reservoir, with respective elevations of 134, 124 and 119 feet. The "head" of the Catskill supply is thus nearly two and a half times that of the Croton, sufficient to send it by gravity to all portions of the Bronx and Brooklyn and to all buildings of average height in other than the very highest portions of the three remaining boroughs. The greater "head" of the Catskill renders it the more valuable of the two supplies.

Only Catskill water is now mainly used for the municipal service in Brooklyn, Queens and Richmond, about 200 m.g.d. being required for this purpose. Such use of Catskill water has made it possible to virtually dispense with the costly pumping of water from the ground in these boroughs and thus to effect an annual saving estimated on the basis of normal prices at about $600,000 net. In addition, about 50 m. g. of Catskill water are being used daily to supply the high ground in the Bronx. The remainder is available for Manhattan and most of it is used in lower Manhattan to supply the important mercantile sections with adequate pressures.

Croton water is used in portions of Manhattan and the Bronx. All that is used on ground with an elevation greater than 40 feet or thereabouts must first be pumped to give it adequate pressure. About 65 m.g.d. are normally being pumped for this purpose at the department's two pumping stations situated respectively at 179th Street and Harlem

River and at 98th Street and Columbus Avenue. The water so pumped serves buildings on certain high ground in upper and central Manhattan. The Jerome Park pumping station in the Bronx, heretofore used to pump Croton water, was idle from February, 1917, when the use of Catskill water in that borough became general, until May, 1919, when the operation of this station was resumed to reduce the draft on Catskill supply. It may not be necessary to run this station in 1920. A small amount of Catskill water is pumped in the Third Ward of Queens and in Richmond for use on the highest ground of those boroughs. In Richmond also about 7 m.g.d. is pumped from wells to augment the Catskill supply.

The only Catskill water available during the next few years will be that from the Esopus watershed, the maximum quantity of which is practically fixed, and any increase in consumption in the areas supplied by it must be obtained from other sources. The only other available sources (until the Schoharie watershed shall have been developed) are (1) pumped Croton water and (2) water to be derived through the resumption of pumping on the Long Island watershed and on Staten Island. The former is a far more economical source of supply than the latter, but after the Jerome Park station shall have again been put in commission and the maximum capacity of this and the two Manhattan stations for pumping Croton water reached (such total maximum capacity being about 100 m.g.d.), it may and doubtless will be necessary again to resort to pumping on the Long Island watershed.

WATER PRESSURES.

Since the introduction of the Catskill supply water pressures in Manhattan have undergone great improvement. In many districts there has been an increase of from 25 to 35 pounds and in several sections the cost of private pumping in buildings has been greatly reduced or the necessity therefor entirely eliminated. Pressures still remain unsatisfactory in certain sections on the east side of Manhattan and in the central part of that borough between 14th and 34th Streets. This has been occasioned by the increased demands for water since the Catskill supply was first furnished and the policy of reducing costs by holding stations in reserve.

There is planned a minimum pressure of 30 pounds

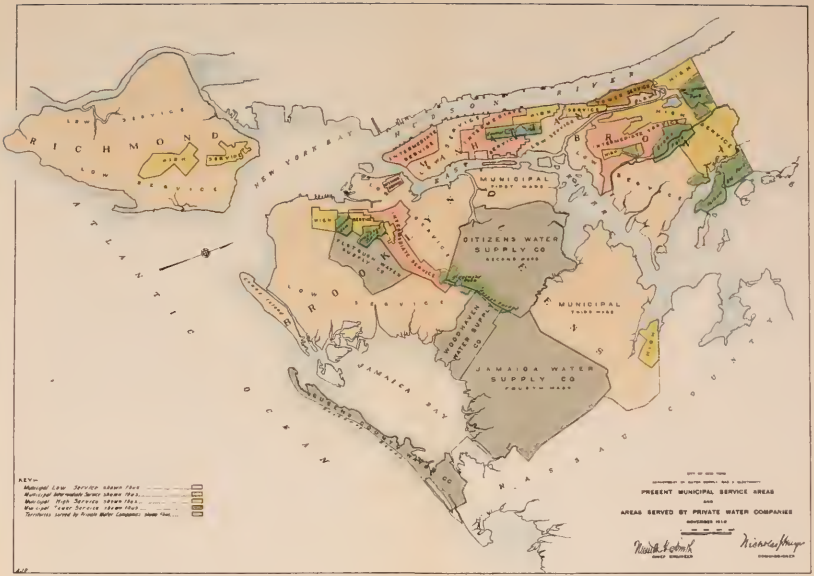
throughout Manhattan and at many places the pressures will be from 60 to 65 pounds.

The pressures in the Bronx have been increased where required, but no general increase was necessary. In Brooklyn there has been an increase of from 5 to 10 pounds throughout the greater part of the low service area. In the First Ward of Queens the pressures have been increased about 20 pounds. There has been no general change in the Third Ward of Queens or in Richmond. The minimum pressure supplied by the municipality in the boroughs of Brooklyn, Queens and Richmond is 30 pounds except in certain small isolated areas, while the average pressure is over 40 pounds.

DISTRIBUTION SYSTEMS.

The demand for water is subject to more or less variation during the course of the day, while during certain morning hours it is twice or three times as great as shortly after midnight. To meet this situation distributing reservoirs are necessary, and the principal ones are those located at Hill View, at Jerome Park and in Central Park.

The total length of city-owned water mains within Greater New York is about 3,000 miles, exclusive of high pressure fire service mains, hereinafter more fully referred to. They vary in diameter from 4 to 66 inches, the usual size on residential streets being 6 or 8 inches. Connected with them are 45,400 fire hydrants. Some 69,000 gates control the flow in the mains and to the hydrants. There are about 397,000 connections, known as services, through which water is drawn for domestic or business purposes. The mains are chiefly of cast iron and some of them were laid as many as seventy-five years ago. The life of a cast iron main depends largely upon the character of the water, although electrolysis and local outside deterioration are occasional factors. In Manhattan at least a hundred years should elapse before internal corrosion so weakens a main as to necessitate its removal. There are cast iron pipes now in use in France which were laid over two hundred and fifty years ago. The cost of an 8-inch main and of the laying thereof is about $6,000 a mile under normal price conditions and where there is no rock excavation. Where there is rock excavation, or where a modern pavement must be cut and replaced, such cost is nearly doubled.


RICHMOND
LOW SERVICE
HIGH SERVICE
NEW YORK BAY
ATLANTIC OCEAN
KILLS
MUNICIPAL
FIRST WARD
CITIZENS WATER
SUPPLY CO
SECOND WARD
MUNICIPAL
THIRD WARD
JAMAICA WATER
SUPPLY CO
FOURTH WARD
JAMAICA BAY
LOW SERVICE
HIGH SERVICE
KEY—
PRESENT MUNICIPAL SERVICE AREAS
AND
AREAS SERVED BY PRIVATE WATER COMPANIES

To cope with the situations which arise when breaks occur in the mains, repair companies are maintained in each borough. There are seventeen of these companies, comprising in all about 675 men. Most of them are manned twenty-four hours a day and all are provided with motor trucks for quick transportation. While during the course of a year several thousand leaks occur in the water mains calling for repairs, yet the number of important breaks is relatively small. The latter are often attributable to the frequent underground changes in the streets of New York which result in the settlement of the fill supporting the mains.

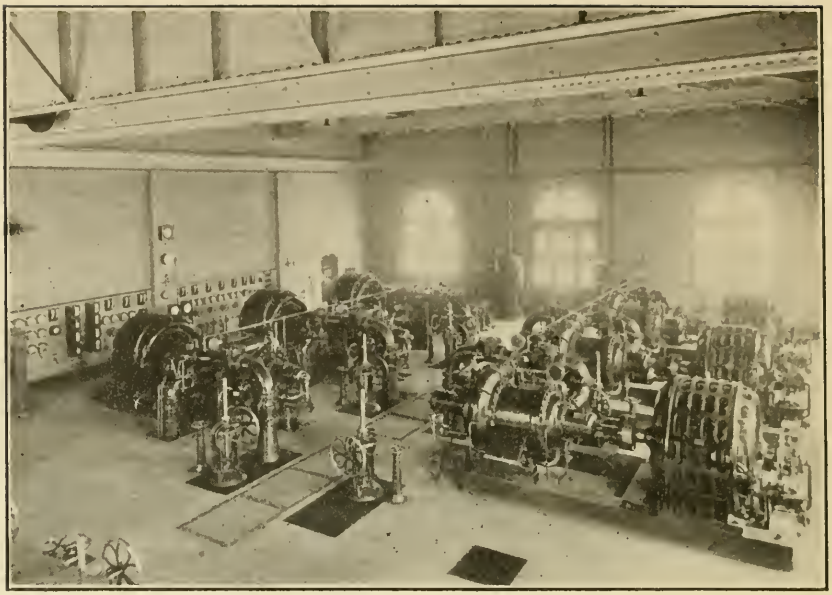
The introduction of Catskill water necessitated many readjustments of the distribution system in all of the boroughs, but this work has been so performed that the system can be readily re-adapted to the old methods of supply.

CONTROLLING THE LOCATION OF SUB-SURFACE STRUCTURES.

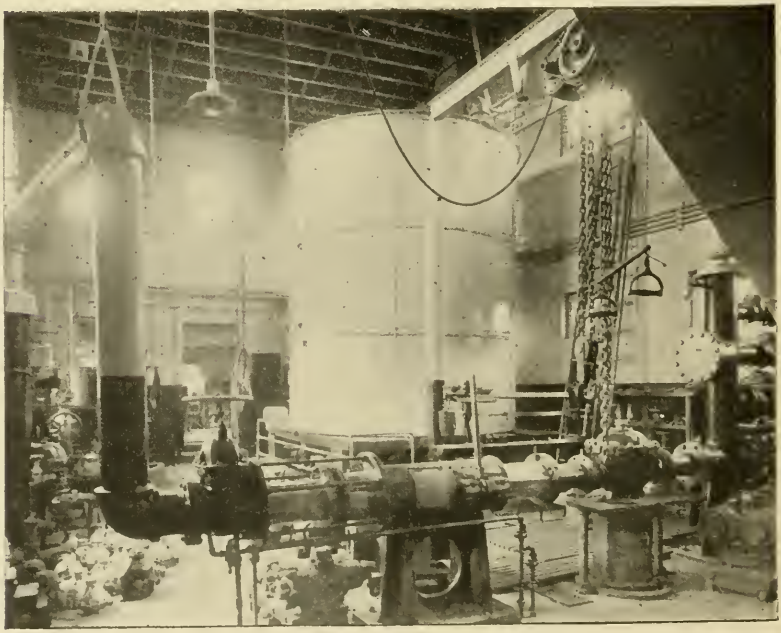
The department determines the location not only of water mains, but of all other sub-surface structures (such as electrical conduits, gas mains, steam pipes and pneumatic tubes) except sewers and rapid transit tunnels. This great power is vested in the department as the successor in interest of the Board of Electrical Control. Its special significance here is that it enables the department to see to it that ready access to water mains is left for the purpose of repairs and connections and that proper space is reserved for the installation of future mains.

HIGH PRESSURE FIRE SERVICE.

The Department of Water Supply, Gas and Electricity has most important duties to perform in connection with the protection of the city against fire. It not only supplies water at the proper pressure and installs the mains through which it runs and the fire hydrants through which it is drawn from the mains, but it also operates in portions of Manhattan and Brooklyn and at Coney Island a special service known as the high-pressure fire service. One of the Manhattan stations is at Oliver and South Streets and the other at Gansevoort and West Streets. There are two similar stations in Brooklyn, located respectively at Furman and Joralemon Streets and



High Pressure Fire Service Pumping Station, Gansevoort Street, Manhattan.



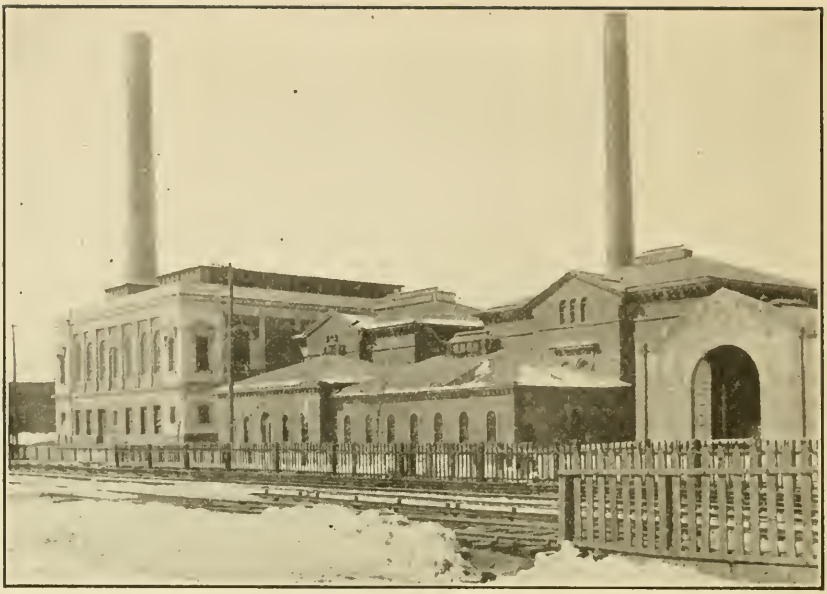
Water Meter Testing Station, Manhattan.

at Willoughby and St. Edwards Streets. The Coney Island station is at Twelfth Street and Neptune Avenue.

There are about 49,500 fire hydrants in Greater New York, 4,100 of which are on the high pressure fire service in the boroughs of Manhattan and Brooklyn. The low pressure fire hydrant furnishes at best a pressure utterly inadequate for the extinguishment of fires in New York. The stream from a fire hose attached to such a hydrant would be insufficient in volume and would not reach beyond the third story of a building. The purpose of the fire engine is to furnish pressure and create an efficient stream, and the pumps at the high-pressure fire service stations perform this service far more efficiently than do the fire engines. Through each of the Manhattan stations a supply of water may be furnished about equal to that of forty fire engines. The capacity of a single high-pressure hydrant is ample to furnish as many fire streams as are furnished by five ordinary fire engines. With a 60-foot water tower in the street the stream may be made to reach the fourteenth story of a building. So great is the pressure furnished by this system that a good stream can be delivered from a standpipe at the top of a forty-story building. In the area served by it fire engines are rarely if ever used, though some are still brought to fires as a matter of precaution.

The length of the high pressure fire service mains in Manhattan is 128 miles, and in Brooklyn 45 miles. The lower East Side of the Manhattan system is arranged so that it may be divided instantaneously into two independent systems; when so divided, each system serves the alternate cross streets and the alternate streets running north and south. In case of a break only one system would be affected, as the other would be shut off from it immediately by valves electrically operated from the pumping stations.

The high pressure fire service stations are operated through high-voltage current furnished in Manhattan by the New York Edison Company, and in Brooklyn by the Edison Electric Illuminating Company. The Coney Island engines are gas driven. Prior to the introduction of the Catskill supply, with its great pressure, the initial pressure furnished in Manhattan was 125 and in Brooklyn 75 pounds per square inch. With Catskill water available a constant pressure of between 100 and 125 pounds per square inch can be main-



Ridgewood Pumping Station, Brooklyn (in Reserve).

Millburn Pumping Station, Long Island Watershed (in Reserve).

tained and the pumps at the stations in Brooklyn are only operated for the larger fires. Upon the request of the Fire Department the pressure can be increased up to 300 pounds per square inch. At Coney Island the limit of pressure is 150 pounds per square inch. When an alarm is received pressure is furnished throughout each of the systems within the period of a minute.

Salt water can be used in this system, but since it corrodes the pipes and damages merchandise, its use is not contemplated in Manhattan or Brooklyn, unless the fresh water supply were to fail, which has never yet occurred. At Coney Island salt water is used in conjunction with fresh water.

MUNICIPAL WATER SUPPLY SYSTEMS PLACED IN RESERVE.

In the early part of 1917, soon after it had been demonstrated that reliance could be placed upon the new Catskill aqueduct, the department began gradually shutting down its water supply system on Long Island, which formerly served the boroughs of Brooklyn and Queens, except in so far as these boroughs were served by private water companies, and that on Staten Island. From ten to thirty days must elapse before operations at most of the pumping stations of these systems can be resumed. Following are brief descriptions thereof.

The main Long Island watershed lies easterly from Brooklyn, extending a distance of about 23 miles to Amityville and containing about 168 square miles. The conditions on this watershed are the exact opposite of those on the Croton watershed, where storage of water on the surface is the economical method of obtaining and holding a large part of the rainfall. On the Long Island watershed the storage of any large quantity of water on the surface is impracticable, owing to the pervious soil and slight changes in ground level, and there are no large storage reservoirs. Most of the water flows underground and must be pumped therefrom. It is collected by infiltration galleries or driven wells. The infiltration galleries laid for nearly six miles about ten to fifteen feet below the water table may be made to yield between 30 and 40 m.g.d., while the driven wells of a depth varying from 30 to several hundred feet furnished formerly 73 m.g.d. There are 24 municipal pumping stations on the main Long Island

watershed; in addition, there are 5 pumping stations within the limits of the Borough of Brooklyn, two of which (those at Ridgewood and Mount Prospect) merely pump water drawn at other stations. The most easterly pumping station is at Massapequa, where a masonry conduit begins through which the water may be conducted by gravity to the Milburn station where it may be pumped at sufficient pressure to deliver it through a combined system of pipe lines and masonry conduit to the Ridgewood pumping station in Brooklyn. There is also a 72-inch steel pipe from Massapequa to Ridgewood. There the water may be pumped to the height necessary to deliver it into the distribution system of Brooklyn, the greater part going first into the Ridgewood reservoir and flowing thence by gravity into the distribution pipes.

The Long Island watershed supplied also the First Ward of Queens, except that this ward received a small amount of water from the municipal pumping stations (now virtually closed down) in the Third Ward. This latter ward was supplied by two pumping stations, one drawing its supply of 2.8 m.g.d. entirely from driven wells and the other drawing its supply of 3.1 m.g.d. partly from driven wells and partly from filtered surface sources. There were no city reservoirs in Queens other than standpipes in the Third Ward, the water being pumped directly into the mains. The Second, Fourth and Fifth Wards, are, as elsewhere stated, supplied by private water companies.

The quality of the water obtained from the Long Island watershed was excellent except where the quantity taken was greater than the fresh water available. This was at times the case, and then the high chlorine content of the admixture of sea water made the water highly corrosive.

The former Staten Island system consisted of six pumping stations drawing subsurface water. The total available sub-surface supply was about 15 m.g.d. There are two small reservoirs (one of them now in use) and a standpipe to equalize the flow. One station remained in operation to pump Catskill water to high level ground. The main station is that at Grant City, completed in 1915, with a capacity of about 7 m.g.d. Appurtenant thereto are five groups of wells, one group at the central station and another at each of four auxiliary stations nearly one mile apart from which the water is drawn

by means of electrically driven pumps deriving power from the central station, the water being delivered by gravity to the steam pumps at the central station.

As the consumption in the borough of Richmond has increased forty (40) per cent since the Catskill supply was introduced it is now necessary to continuously operate the Grant City station. The Narrows siphon will deliver only two-thirds of the necessary supply.

WATER REVENUE.

The city's water revenue is collected through what is known as the Bureau of Water Register, except that accounts in arrears are collected by the Finance Department. All water charges are established by joint action of the Board of Aldermen and the Commissioner of this department. At the close of 1919 there were 387,000 consumers' accounts, of which 269,000 were what are known as "frontage," and 118,000 as meter accounts. It is estimated that about 25 per cent. of the water supplied to the city is metered. During 1919, $7,073,249 of revenue accrued through frontage accounts and penalties, while approximately $7,653,218 accrued through meter accounts and penalties, making a total of $14,726,467 to which should be added the proceeds from water sold for building purposes, for washing sidewalks, for street sprinkling and for use of vessels, also certain miscellaneous revenue and penalties, totaling $343,765. Frontage rates vary from $4 for a one-story building sixteen feet wide, to $14 for a one-story building fifty feet wide. To these rates $2 is added for each ten feet in excess of fifty feet frontage, and $1 for each story above the first. The foregoing items yield only about 35 per cent. of the amount derived through frontage accounts. About 52 per cent. additional is derived in nearly equal shares from charges for baths and for toilets in excess of one per building and 13 per cent. from charges for families in excess of one in any building. There are other miscellaneous charges, but they contribute only a small portion of the frontage revenue. The charge for metered water is ten cents per 100 cubic feet.

The cost of collecting the water revenue is about $3.520 per $100,000, which includes the cost of inspecting premises to determine the proper charges, of the reading of meters, of the

keeping of consumers' accounts, of the preparation of bills with subsequent adjustments as to many, and of the issuance of some 70,000 permits.

VALUE AND COST OF MAINTAINING AND OPERATING THE WATER SUPPLY SYSTEM.

The estimated cost of the city's water works system, including the Catskill and Croton watersheds, as well as the Brooklyn and other watersheds now held in reserve, is about $341,500,000. The total water revenue for the year 1919 was approximately $15,070,000. The expenses of the Department of Water Supply, Gas and Electricity in the operation and maintenance of the water works and in the collection of the water revenues in 1919 were about $3,700,000. The interest and sinking fund charges on the old water debt (i.e., exclusive of the Catskill debt) amount to $4,000,000, and on the bonds issued for the Catskill project, to slightly over $7,100,000. The prices of labor and materials and other uncertainties resulting from the war, make it hazardous to venture a definite estimate as to what will be the department's expenses for operation and maintenance of the water supply system during the next few years.

The water revenue for the year 1919 left the city with a small surplus for the first time since the introduction of the Catskill supply; and although maintenance costs are steadily increasing, the average annual increase in revenue of about $350,000 should in a few years again bring about a favorable balance.

PRIVATE WATER COMPANIES.

Although it is not the purpose of this pamphlet to discuss these companies in any detail, yet a brief reference thereto is necessary, since some 400,000 citizens residing in Brooklyn and Queens and consuming about 40 m.g.d. are still dependent upon them for water. All of these companies draw their supplies from driven wells. The one located within the Borough of Brooklyn is the Flatbush Water Works Company, serving the Twenty-ninth Ward (Flatbush). In the Borough of Queens the Citizens' Water Supply Company of Newtown and the Urban Water Company furnish water for the Second Ward, the Jamaica Water Supply Company and the Woodhaven Water Supply Company for the Fourth Ward and the

Queens County Water Company for the Fifth Ward. With one exception (the Flatbush Water Works Company) their franchises are non-exclusive. In the Second Ward of Queens, served principally by the Citizens' Water Supply Company, the City has heretofore made a heavy investment in trunk mains. For the amounts of water supplied by these companies, reference is made to Table No. 8.

These companies are under the general superintendence, regulation and control of the Commissioner of Water Supply, Gas and Electricity. With the many perplexing features of this relationship it does not fall within the purview of this pamphlet to deal.

NICHOLAS J. HAYES,
Commissioner.

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TABLE NO 1.

Rainfall, and Yield of Catskill and Croton Watersheds 1910-1919.

	Catskill (Esopus) Watershed — Area—257 sq. miles — Safe yield—250 m.g.d.			Croton Watershed — Area—375 sq. miles — Safe yield—336 m.g.d.		
	Rainfall inches (Aver. of 10 Stations)	Yield M.g.d. per sq. mile of watershed	Yield per cent of rainfall	Rainfall inches (Aver. of 9 Stations)	Yield M.g.d. per sq. mile of watershed	Yield per cent of rainfall
1910	48.2	1.486	65	43.2	0.883	43
1911	43.8	1.253	60	48.1	0.912	40
1912	50.1	1.576	66	45.6	1.045	48
1913	48.1	1.586	69	49.3	1.277	54
1914	39.6	1.290	68	39.4	1.072	57
1915	52.6	1.663	66	51.8	1.189	48
1916	45.0	1.648	77	41.9	1.315	66
1917	46.2	1.496	67	36.3	0.763	43
1918	43.1	1.153	56	41.1	0.850	43
1919	51.5	1.522	62	50.5	1.378	57
Aver. for 10 years..	47.1	1.463	65	44.7	1.068	50

TABLE NO. 2.

Storage Reservoirs in Watersheds.

Name.	Year first placed in service.	*Elevation of spillway, feet.	Storage with flashboards, million gallons.
Catskill Watershed—			
Ashokan	1915	590	130,400
Kensico	1915	355	30,573
Croton Watershed—			
Boyd's Corners	1873	600	2,727
Middle Branch	1878	380	4,155
East Branch	1891	417	5,243
Bog Brook	1891	417	4,400
West Branch	1895	503	10,669
Amawalk	1897	400	7,086
Croton Falls	1911	310	15,753
Titicus	1893	325	7,617
Cross River	1908	330	10,923
Croton Lake	1905	200	33,815
Lake Mahopac	1870	660	575
Lake Kirk	1870	583	565
Lake Gleneida	1870	505	165
Lake Gilead	1870	497	380
Barret's Pond	1870	779	170
White Pond	1890	831	200
Totals			104,443
Bronx and Byram Watersheds—			
Byram	1897	452	925
Wampus	1897	458	87
			1,012
Long Island Watershed—			
Hempstead	1879	30	880
12 Ponds			220
			1,100

*Elevations on Croton Watershed refer to Croton datum. Other elevations refer to mean sea level at Sandy Hook, which is 0.94 feet above Croton datum.

TABLE NO 3.

Aqueducts and Pipe Lines.

Description	Limits	Length Miles.	Type.	Rated Capacity, M. G. D.
Catskill Aqueduct	Ashokan	55	Cut-and-cover	
	Reservoir to	14	Grade tunnel	
	Hillview	17	Pressure tunnel	600
	Reservoir	6	Steel pipe siphon	
Catskill Aqueduct (City Tunnel)	Hillview Reservoir to Brooklyn	18	Pressure tunnel	
New Croton Aqueduct	Old Croton Dam	22.5	Grade tunnel	
	to 135th St.	1.5	Cut-and-cover	300
	Gate House	7	Pressure tunnel	
Old Croton Aqueduct	Old Croton Dam	33	Cut-and-cover	
	to Central Park	2	Grade tunnel	90
	Reservoir	3	C. I. & Steel pipe	
Bronx Pipe Line	Kensico Res. to W'msbridge Res.	15.2	Cast-iron pipe	
Long Island Brick Conduits	Massapequa Pond to Milburn Pumping Station	7.3	Cut-and-cover	59
	Hempstead Pond to Ridgew'd P. S.	12.4	Cut-and-cover	76
Long Island 72-inch Steel pipe	Suffolk Co. Line to Pitkin Avenue, Brooklyn	23.4		57
Long Island Cast iron pipes	Milburn P. S. to Ridgewood P. S., (2-48″)	15		50
	Milburn P. S. to old Milburn Res. Efflux (48″)	1.6		25
	Old Milburn Res. Efflux to Smith's Pond (36″)	1.4		14
	Spring Creek to Ridgewood P. S. (48″)	0.9		25
	Pitkin Avenue, B'klyn, to Ridgewood P. S. (48″)	0.7		25

TABLE NO. 4.

Typical Analyses of Sources of Supply.

KIND OF EXAMINATION	Catskill water at Hillview Reservoir	Croton water at 135th St. Gate H.	L. I. water at Ridgewood Res.	PRIVATE WATER COMPANIES: Citizens W. S. Co. at Sta. No. 3.	Jamaica W.S. Co. at Sta. No. 2.	Queens Co. W. S. Co. at Val. Strm.	Woodhaven W. S. Co.	Flatbush Water Works Co.
Physical Examination—								
Turbidity—P. P. M. of Silica	2	2	2	2	3	1	1	0
Color—P. P. M. of Platinum	9	14	9	8	5	2	2	3
*Odor	1v	1v	1e	0	Gas	0	0	0
Per cent of samples with distinct vegetable odors	0	0	0	0	0	0	0	0
Per cent of samples with odor of decomposition	10	0	0	0	0	0	0	0
Per cent of samples with odor due to organisms	0	1	0	0	0	0	0	0
Chemical Examination—								
Albuminoid Ammonia								
In solution	0.043	0.090	0.020	...	...	...	...	...
In suspension	0.004	0.016	0.007	...	...	...	...	...
Total	0.047	0.106	0.027	0.006	0.012	0.010	0.006	0.004
Free Ammonia	0.010	0.009	0.042	0.015	0.010	0.002	0.003	0.014
Nitrites	0.002	0.002	0.002	0.007	0.003	0.001	0.001	0.006
Nitrates	0.10	0.18	1.04	1.88	3.0	0.11	6.77	5.25
Total Solids	38.	72.	131.	214.	159.	54.	172.	219.
Loss on Ignition	14.	22.	...	...	...	...	...	...
Fixed Solids	24.	50.	...	...	...	...	...	...
Chlorine	1.3	2.9	30.3	25.5	15.2	4.8	9.5	13.6
Hardness	18.	38.	45.	133.	75.	14.	100.	140.
Alkalinity	8.	31.	14.	93.	27.	10.	55.	85.
Iron	0.14	0.16	0.63	0.33	0.56	0.07	0.12	0.08
Microscopical Examination—								
Microscopic organisms	525	336	31	0	0	0	0	0
Amorphous matter	380	263	492	180	155	25	74	45
Bacteriological Examination—								
Bacteria per c.c. (37 deg. C.)	22	18	16	14	22	...	5	4
Per cent positive tests for								
B. coli in 0.1 c.c.	0	0	0	0	0	0	0	0
in 1.0 c.c.	2	2	0	20	0	0	0	0
in 10.0 c.c.	23	19	0	60	0	0	0	0

*1v, faintly vegetable. 1e, faintly earthy.

TABLE NO 5.

Average Daily Consumption in New York City From 1910 to 1919 Expressed in Million Gallons.

	Man. and the Bronx	—Brooklyn— Muni-cipal	Pri-vate	—Queens— Muni-cipal	Pri-vate	—Richmond— Muni-cipal	Pri-vate	——Total—— Muni-cipal	Pri-vate
1910....	331	143	15	13	18	9.0	0.1	496	33
1911....	298	140	15	13	18	10.0	0.1	461	33
1912....	303	142	16	14	20	10.0	0.1	469	36
1913....	314	124	16	14	19	12.0	0.1	464	35
1914....	347	134	16	15	21	12.0	0.1	508	37
1915....	341	129	14	13	19	12.0	0.1	495	33
1916....	365	136	15	13	25	13.0	0.1	527	40
1917....	374	140	14	19	25	12.0	0.1	545	39
1918....	413	170	13	16	30	16.5	0.0	616	43
1919....	417	169	13	16	28	17.0	0.0	619	41

TABLE NO. 6.

Average Daily Per Capita Consumption in New York City in 1910 and 1919.

	1910 Population	1910 —Average Daily— Consumption Total	1910 Gals. per Capita	1919 Population	1919 —Average Daily— Consumption Total	1919 Gals. per Capita
Manhattan and Bronx.....	2,762,500	334.0	120	3,440,000	417.4	121
Brooklyn	1,634,350	158.0	97	2,079,000	181.6	87
Queens	284,040	30.0	106	410,000	44.2	108
Richmond	85,970	9.0	105	104,000	17.0	164
Total.....	4,766,860	528.0	111	6,033,000	660.2	109

TABLE NO. 7.

Consumption in Various American Cities in 1919.

City.	Population.	Daily Consumption Million Gals.	Daily Consumption Gallons per Capita.	Percentage of Taps Metered.
New York.....	6,033,000	660.2	109	37
Chicago	3,000,000	720.8	240	9
Philadelphia	2,000,000	320.0	160	22
Cleveland	1,050,000	127.6	121	100
Boston	807,600	89.7	111	60
St. Louis.....	780,000	100.9	130	8

TABLE NO. 8.

Average Daily Consumption in New York City During 1919, Expressed in Million Gallons.

	Manhattan & Bronx				Brooklyn				Queens			Richmond			All Boroughs	
	Croton				Long Island											
	Catskill	Pumped	Gravity	Total	Total	Catskill	& Borough (pumped)	Total	Catskill	Borough (pumped)	Total	Catskill	Borough (pumped)	Total	Total Catskill	Total all Municipal Sources
January	202.9	57.7	147.0	204.7	407.6	170.1	...	170.1	15.2	...	15.2	13.4	3.8	17.2	401.6	610.1
February	206.8	57.6	139.2	196.8	403.6	164.2	0.2	164.4	14.6	...	14.6	13.7	3.3	17.0	399.3	599.6
March	196.5	57.2	139.9	197.1	393.6	155.4	0.03	155.4	14.7	...	14.7	14.2	1.2	15.4	380.8	579.1
April	181.4	59.0	152.6	211.6	393.0	158.4	...	158.4	15.5	...	15.5	14.6	0.2	14.8	369.9	581.7
May	166.7	66.1	165.7	231.8	398.5	158.0	1.5	159.5	16.2	...	16.2	14.6	0.9	15.5	355.5	589.7
June	150.1	93.5	180.4	273.9	424.0	170.0	...	170.0	17.0	...	17.0	13.1	4.0	17.1	350.2	628.1
July	156.5	90.4	182.1	272.5	429.0	157.3	15.5	172.8	15.5	0.8	16.3	12.5	5.1	17.6	341.8	635.7
August	154.8	85.3	186.1	271.4	426.2	154.6	17.4	172.0	15.7	...	15.7	10.1	7.9	18.0	335.2	631.9
September	167.1	86.8	175.6	262.4	429.5	176.6	0.3	176.9	16.3	...	16.3	11.5	6.8	18.3	371.5	641.0
October	170.0	92.1	164.8	256.9	426.9	173.5	...	173.5	16.3	...	16.3	10.9	6.6	17.5	370.7	634.2
November	172.5	87.1	173.1	260.2	432.7	167.7	...	167.7	15.7	*0.1	15.8	11.3	5.9	17.2	367.2	633.4
December	172.2	87.2	184.4	271.6	443.8	181.6	0.1	181.7	16.6	*0.2	16.8	12.6	6.2	18.8	383.0	661.1
Aver. for Year Public Systems	174.6	76.8	166.0	242.8	417.4	165.6	3.0	168.6	15.8	0.1	15.9	12.7	4.3	17.0	368.7	618.9
Aver. for Year Private Systems	....	....	.....	.....	.....	.....	...	13.0	....	...	28.3	....	...	....	.....	41.3
Total					417.4			181.6			44.2			17.0		660.2
Estimated Population					3,440,000			2,079,000			410,000			104,000		6,033,000
Per Capita (in gallons)					121			87			108			164		109

*From Citizens Water Supply Co., to Little Neck and Douglaston.

Water Supplied by Private Companies, in Million Gallons, Daily.

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year 1919
BROOKLYN													
Flatbush Water Works Co. (Supplies 29th Ward)	12.5	12.4	12.5	12.9	12.9	13.8	13.6	13.0	13.5	13.2	13.0	13.1	13.0
QUEENS													
Citizens Water Supply Co. (Supplies Greater part of 2nd Ward)	12.14	12.47	11.67	10.85	10.82	12.57	13.15	12.38	12.55	12.92	12.65	12.02	12.18
Urban Water Supply Co. (Supplies small part of 2nd Ward)	1.77	1.48	1.20	1.19	1.34	1.20	1.24	1.34	1.34	1.21	1.05	1.17	1.29
Jamaica Water Supply Co. (Supplies a part of 4th Ward)	6.04	6.05	5.93	6.37	6.45	7.02	6.88	6.46	6.50	6.43	6.48	6.83	6.46
Woodhaven Water Supply Co. (Supplies a part of 4th Ward)	3.06	3.01	3.00	2.77	3.28	3.71	3.79	3.40	3.31	3.36	3.21	3.25	3.26
Queens County Water Co. (Supplies 5th Ward)	1.85	1.71	1.57	1.81	2.53	4.55	6.02	5.90	4.07	2.30	2.01	2.23	3.05
Broad Channel Corp. (Supplies small part of 5th Ward)	....	....	.01	.01	.01	.01	.04	.04	.01	.01	.01	.01	.02
Montauk Water Co. (Supplies Long Island Railroad)	2.00	1.80	2.10	2.00	1.90	1.90	2.10	1.90	2.40	2.00	1.90	2.50	2.00
Total for Queens	26.86	26.52	25.48	25.00	26.33	30.96	33.22	31.42	30.18	28.23	27.31	28.01	28.26

TABLE NO. 9.

Estimated Consumption in the Various Services of the Municipal System During the Years 1918 and 1919.

Borough.	Service.	Distribution Point.	Elev. Feet.	Estimated Daily Consumption in M. G. 1918.	1919.
Manhattan	Low	135th Street Gatehouse	124.8	106.3	107.4
		Central Park Reservoir	119.4		
	Intermediate	Highbridge Reservoir	218.0		
		98th Street Standpipe	228.1	165.3	160.0
		Hillview Reservoir (reduced)	230.0		
	High	Hillview Reservoir	295.0	33.0	36.0
	Tower	Highbridge Tower	336.0	7.7	8.3
				312.3	311.7
Bronx	Low	Jerome Park Reservoir	136.5	33.0	36.0
	Intermediate	Williamsbridge Reservoir	193.3	40.0	40.7
		Hillview Reservoir (reduced)	200.0		
	High	Jerome Park Tower	316.7		
		Hillview Reservoir	295.0	28.0	29.0
				101.0	105.7
Brooklyn	Low	Ridgewood Reservoir	171.7	133.0	131.3
	Intermediate	Mt. Prospect Reservoir	199.7	25.0	25.2
	High	Mt. Prospect Tower	275.7	12.0	12.1
				170.0	168.6
Queens	1st Ward	Hillview Res. (reduced)	174.7	11.5	11.3
	3rd Ward	Flushing Standpipe	223.7		
		College Point Standpipe	194.7	4.7	4.6
				16.2	15.9
Richmond	Low	Tottenville Standpipe	150.8	14.0	14.7
		Silver Lake Reservoir	228.9		
	Intermediate and High	Clove Reservoir	258.0		
		Grymes Hill Standpipe	452.8	2.5	3.3
				16.5	18.0
		Grand Total		616.0	619.9

Elevations refer to mean sea level at Sandy Hook

TABLE NO. 10.

Chlorinating Plants.

Location	Water Treated	Type of Plant.	Chlorine used. Parts per million by w't. High.	Low.	Ave.
Dunwoodie	Croton Supply	Liquid Chlorine	0.3	0.15	0.20
Kensico	Catskill Supply	Liquid Chlorine	0.2	0.10	0.14
Katonah	Katonah Brook	Hypochlorite of Lime	9.0	2.0	3.3
Mt. Kisco	Kisco River	" " "	2.0	1.3	1.6
Mt. Kisco	Effluent from Mt. Kisco Sewage Disposal Plant	" " "	24.0	10.9	15.00
Carmel	Lake Glenecida	" " "			0.2
Brewster	Tonetta Brook	" " "	5.4	1.5	2.06
Brewster	Brewster Sewage	" " "			400.00
Phonecia	Esopus River	" " "			0.15

TABLE NO. 11.

Distribution Reservoirs and Standpipes.

Borough	Name.	Normal Water level. Elev., feet.	Storage, Million Gallons
	*Hillview Reservoir	295	929
Manhattan	High Bridge Reservoir	218	11
	Central Park Reservoir (old)	119	220
	Central Park Reservoir (new)	119	985
	High Bridge Standpipe	336	...
	98th Street Standpipe	229	...
Bronx	Jerome Park Reservoir	134	773
	Williamsbridge Reservoir	193	147
	Jerome Avenue Standpipe	320	...
Brooklyn	Ridgewood Reservoir (3 basins)	172	300
	Mt. Prospect Reservoir	200	19
	Mt. Prospect Tower	280	0.1
Queens Municipal	Flushing Standpipe	221	0.8
	College Point Standpipe	192	0.9
	Whitestone Standpipe	181	0.2
Richmond	Silver Lake Reservoir	228	438
	Clove Reservoir	254	2.7
	Grimes Hill Standpipe	453	0.2
	Tottenville Standpipe	143	0.1

*North of City Line

TABLE NO. 12.

Distribution System (December 31, 1919).

DISTRIBUTION MAINS

Diam. Inches.	Manhattan & The Bronx	Brooklyn	Queens	Richmond	All Boroughs
66	.....	29,316	.....	.....	29,316
60	804	3,571	.....	.....	4,375
48	246,263	193,384	13,953	4,335	457,935
42	.....	4,066	.....	.....	4,066
36	288,321	79,527	.....	399	368,247
30	60,426	90,527	47,426	16	198,395
24	12,942	42,053	43,006	52,786	150,787
20	543,626	373,484	42,066	60,769	1,019,945
16	34,151	268,409	36,250	51,979	390,789
14	1,784	3,159	7,530	10,683	23,156
12	2,344,452	579,460	279,368	292,562	3,495,842
10	10,900	19,601	31,943	29,134	91,578
8	178,613	1,796,586	547,377	308,518	2,831,094
6	3,267,410	2,319,886	314,129	323,588	6,225,013
4	131,575	143,574	41,663	306,681	623,493
Total feet	7,121,267	5,946,603	1,404,711	1,441,450	15,914,031
Total miles	1,348.72	1,126.25	266.04	273.00	3,014.01

DISTRIBUTION VALVES.

Size Inches					
48	63	31	..	..	94
36	142	86	5	4	237
30	48	87	10	..	145
24	21	102	15	24	162
20	688	726	72	84	1,570
16	38	729	41	53	861
14	..	1	9	20	30
12	7,479	1,758	794	365	10,396
10	9	7	48	43	107
8	683	5,625	1,509	1,013	8,830
6	22,715	16,712	2,543	3,006	44,976
4	379	224	38	1,035	1,676
Total	32,265	26,088	5,084	5,647	69,084

HYDRANTS.

Total	20,426	18,820	3,221	2,921	45,388

TAP AND METERS.

Taps	186,745	177,995	13,818	*18,431	396,989
Meters	61,992	31,413	8,347	6,284	108,036
Per cent of taps metered	43.20	17.64	60.41	34.09	36.75
Per cent of Aver. daily supply metered	24.1	24.8	48.4	28.8	25.0

*Includes private service line connections.

TABLE NO. 13.

High Pressure Fire Service System (December 31, 1919).

Diam. Inches	Length of Mains Manhattan feet	Length of Mains Brooklyn feet	Number of Valves Manhattan	Number of Valves Brooklyn	Number of Hydrants Manhattan	Number of Hydrants Brooklyn
24	50,029	.....	.....	.....		
20	57,014	62,141	296	141		
16	134,691	72,764	*391	171		
12	377,567	87,801	1,268	229		
8	55,645	12,500	2,754	1,369		
6	846	....	42	....		
Total...	675,794	235,206	4,751	1,910	2,751	1,363
Total miles.	127.99	44.55				

*Includes 5 motor operated valves.

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